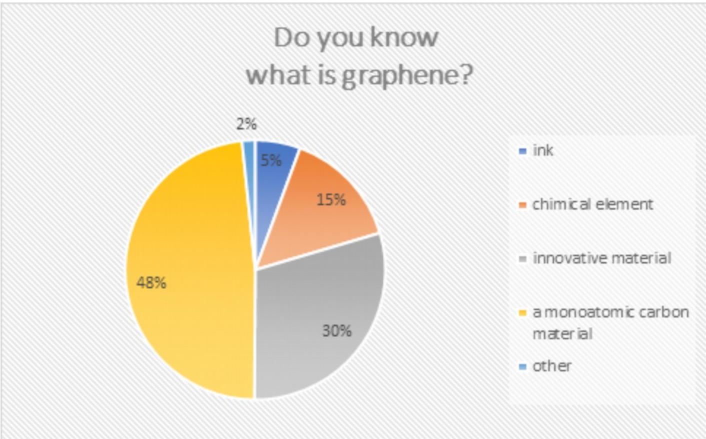
GRAPHENE

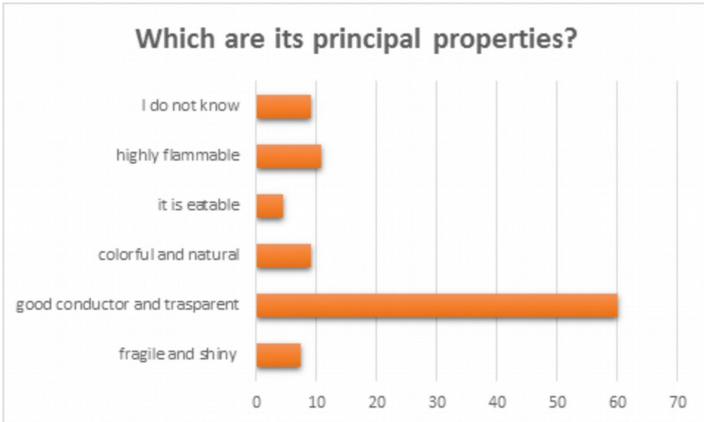
What is it?!
This is a magazine created by class 3A from Liceo Copernico of Bologna.

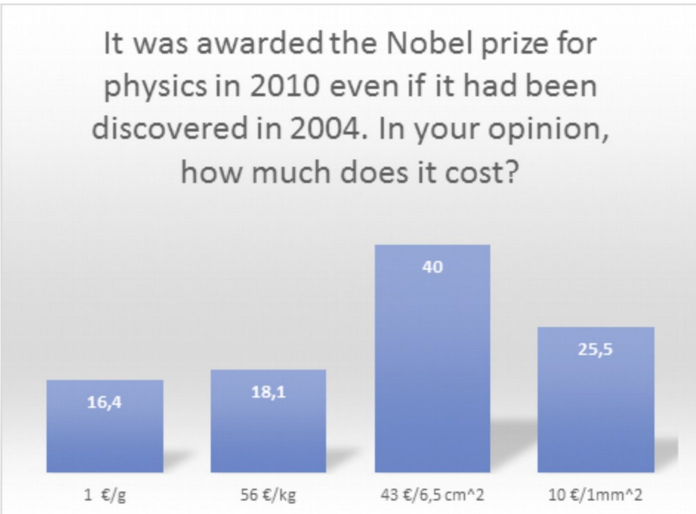
And there is a lot more!

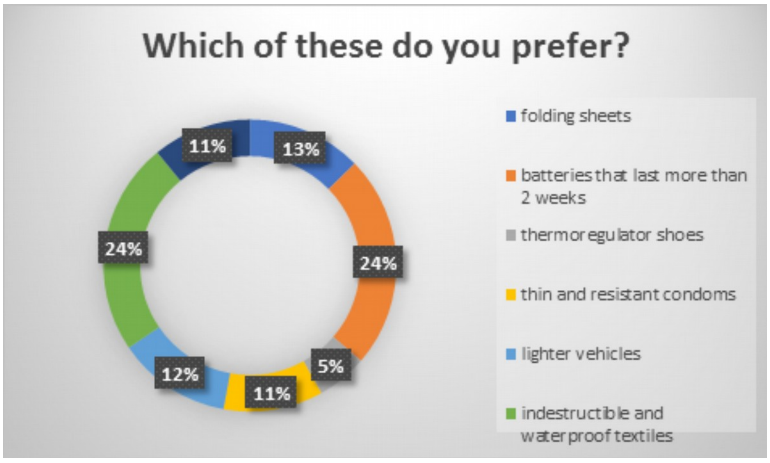
GRAPHENE SURVEY'S RESULTS

Have you got any idea of what graphene actually is? First take a look to the results of a survey, based on the responses of 500 people we interviewed. Then read our journal and check if your knowledge about this new material was correct.







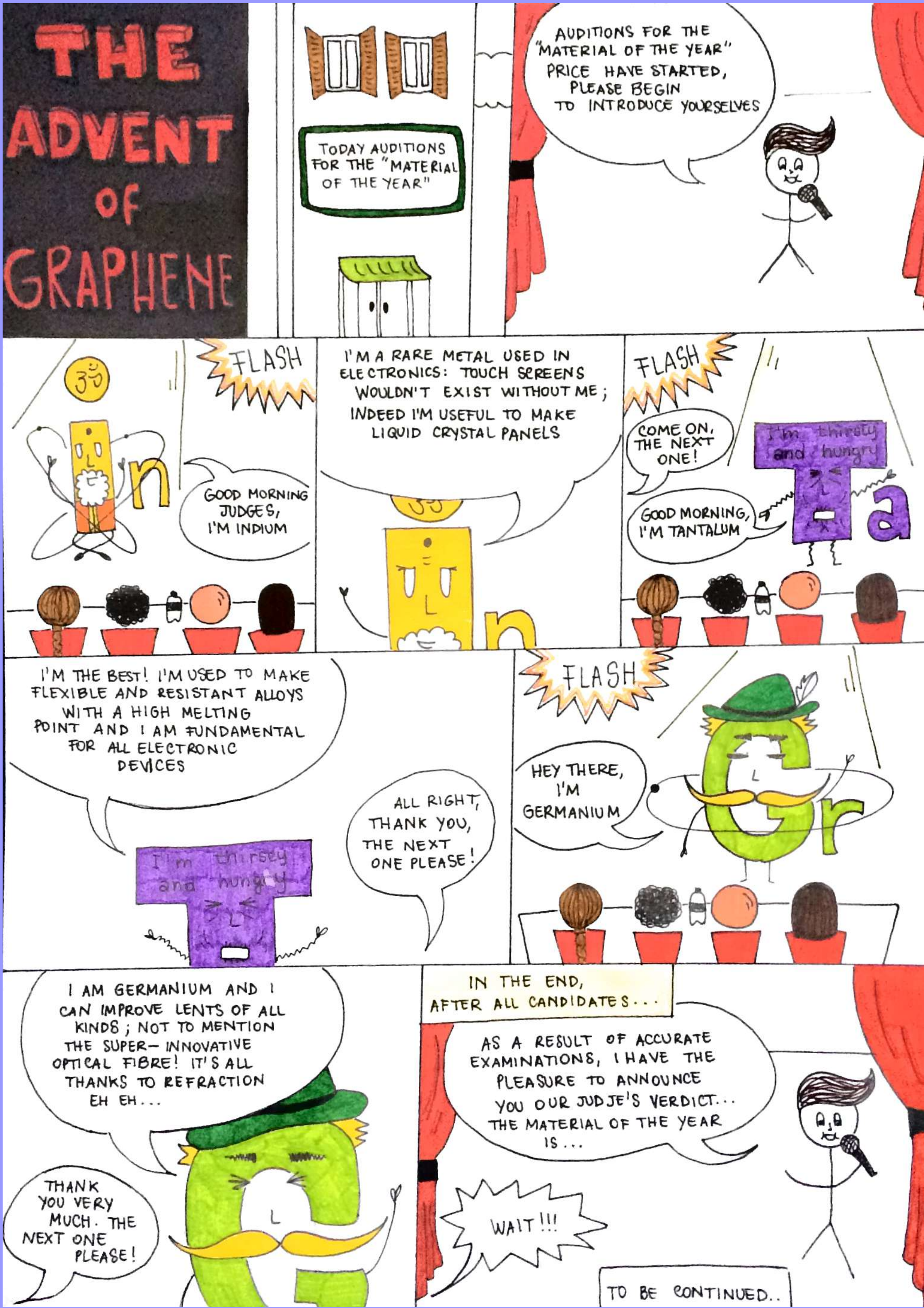


DO THE SURVEY YOURSELF!

https://docs.google.com/forms/d/e/1FAIpQLScgaKJ3Zkm33Z0iX2kzyd42KulW3qpJFCRAfqg8YTJf0zcc6Q/viewform?c=0&w=1

FROM GRAPHITE TO GRAPHENE

The possibility of graphene's existence as a two-dimensional (2D) allotrope of carbon has been theoretically studied for 60 years. The term graphene was often used to describe the properties of carbon allotropes. However, after four decades the first graphene's "toy" model has been realised. Graphene was expected to be unstable due to the formation of curved structures such as soot, fullerenes, and nanotubes. Further, graphene was believed not to exist in its free state. Unexpectedly, in 2004, the prediction of graphene's existence became true when freestanding graphene was discovered on the 22th October 2004, as Gejm e Novoseelov, "playing" with adhesive tape and a graphite block (precisely the one we use for pencil leads), discovered almost by chance the world's thinnest material, composed of a single layer flat of carbon atoms that are tightly packed into a honeycomb-like crystal and bound together by weak Van der Waals forces.
To understand the path we have taken concerning researches on graphene, it can be useful to consider it simply as a lesser extent of a graphite layer, which is itself one of the carbon allotropes. As a consequence, it wouldn't make sense to mention graphene without travelling back in time, in order to shed light on what we could call "graphite's history": its use and what it has meant to human being through the ages.
Plentiful and natural, graphite has been known by humans as a mineral for almost 500 years, starting right over the artistic, scientific, cultural heyday, in most of Europe represented by the Renaissance. Its first use was to make the sheeps, and it became of primary importance for the first time in England when the enlightened Elizabeth I Tudor (1558-1603) decided to use it to realize cannonballs' moulds, which emerged overpoweringly in the European war stage right at the time. Over this period, they used to call it "plumbago", "Molibdaena" or "black lead", referring to lead and molybdenum, actually missing in its chemical composition. Graphite was also named as "painters' mica", as it has a lamellar structure and leaves trails on paper. Indeed, its name comes from the Greek word γράφω (grafo), which means "I write" (γραφειν "grafein", is the infinitive).
However, graphite became permanently the material used to write with pencils only around the turn of XVIII and XIX centuries and, at the same time, the German geologist and mineralogist Abraham Gottlob Werner coined the name we still use nowadays: graphite.
Coming back to the present, graphene synthesis starts from Gejm's idea of reducing graphite blocks to a only 10-100 layers thickness and so studying with a greater precision material properties. One of his students who had been assigned to carry out this arduous task had produced a 1000 layers thick graphene grain when Gejm thought about using tape to peel back the upper layer. This process was repeated many times to obtain increasingly thin layers embedded in the tape. Gejm and his staff then dissolved the tape in solution, obtaining only 10 layers thick graphite.
In a few weeks his expert colleagues had already started to produce primitive transistors with the new material. With further technical development first graphene sheets were created. "We fooled nature by making first a three-dimensional material, which is graphite, and then pulling an individual layer out of it", said Gejm with a triumphant voice, talking about his brilliant insight. In a little while, Gejm published an article on the production of graphene sheets in the Science Magazine, one of the most prestigious in the world, titled "Effect of the electric field on atomic thin carbon layers". This is today one of the most frequently quoted materials in the physics of materials, and by 2005, the researchers managed to isolate multiple sheets of graphene.
Subsequently, Gejm and Novoselov were awarded the Nobel Prize in Physics in 2010, which is rare a few years after the discovery, and today they teach, as at the time of their outstanding discovery, at the University of Manchester.
Meanwhile, industry and research have begun to explore the boundaries of this matter by discovering that it could do miracles, thus increasing graphene as the ideal candidate for technological applications over the next few years.


THE ADVENT OF GRAPHENE
TODAY AUDITIONS FOR THE "MATERIAL OF THE YEAR"
AUDITIONS FOR THE "MATERIAL OF THE YEAR" PRICE HAVE STARTED, PLEASE BEGIN TO INTRODUCE YOURSELVES
FLASH
GOOD MORNING JUDGES, I'M INDIUM
I'M A RARE METAL USED IN ELECTRONICS: TOUCH SCREENS WOULDN'T EXIST WITHOUT ME; INDEED I'M USEFUL TO MAKE LIQUID CRYSTAL PANELS
FLASH
COME ON, THE NEXT ONE!
I'm thirsty and hungry
GOOD MORNING, I'M TANTALUM
I'M THE BEST! I'M USED TO MAKE FLEXIBLE AND RESISTANT ALLOYS WITH A HIGH MELTING POINT AND I AM FUNDAMENTAL FOR ALL ELECTRONIC DEVICES
ALL RIGHT, THANK YOU, THE NEXT ONE PLEASE!
FLASH
HEY THERE, I'M GERMANIUM
I AM GERMANIUM AND I CAN IMPROVE LENTS OF ALL KINDS; NOT TO MENTION THE SUPER-INNOVATIVE OPTICAL FIBRE! IT'S ALL THANKS TO REFRACTION EH EH...
THANK YOU VERY MUCH. THE NEXT ONE PLEASE!
IN THE END, AFTER ALL CANDIDATES...
AS A RESULT OF ACCURATE EXAMINATIONS, I HAVE THE PLEASURE TO ANNOUNCE YOU OUR JUDJE'S VERDICT... THE MATERIAL OF THE YEAR IS...
WAIT!!!
TO BE CONTINUED..

SCIENCE AND TECHNOLOGY OF GRAPHENE

Graphene, you may have heard of it, the new wonder material or something like that. But what exactly graphene is, I mean what is scientifically?

Before examining graphene, we need to talk about carbon, one of the most abundant elements in the universe, an element at the bottom of known life.
One of the most interesting properties of carbon is its capacity to form allotropes (from greek allos, other and tropos, way) that are different forms of the same substance.
In regard to carbon we recognize two different allotropes: diamond and graphite.

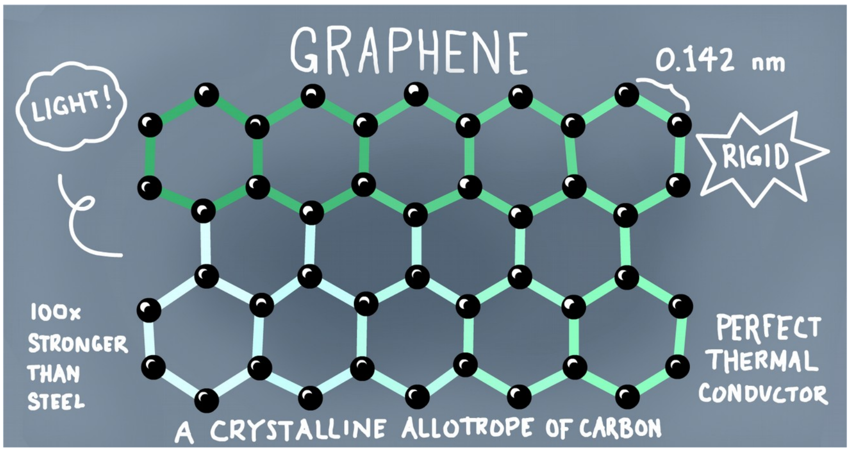
Even if the diamond looks more precious and we see graphite only when we write, they are both important and interesting, as a matter of fact is from graphite that graphene comes.
To understand better how graphite is composed you can imagine it as a book, imagine that the book is composed of a lot of pages. Every page is what we call graphene.
A process called horbital ibridazation gives it the classic honeycomb form.

A sheet of infinite hexagons with very strong bonds between the atoms and very weak bonds between every sheet.
The thing that sounds really incredible is that the thickness of the leaves is only one atom so we can talk about a monoatomic sheet.
If we think to the way that has been used to isolate the first graphene sheet, it might sound like an original tale.
The two physics Andrej Gejm and Konstantin Novoselov, who won the nobel prize in 2010 thanks to this discovery, used a method called "scotch" tape, it consists in exfoliate a scrap of graphite with a piece of scotch until reaching a single monoatomic leaf.

Its special properties derive from bonds between the atoms, very strong; the versatility is one of its qualities.
It's extremely resistant, 100 times more than steel, but flexible and trasparent.
The electric and termic conducibility is higher in graphene than in any other material (for example in copper).
The applications are really infinite, but we will see them in the next articles.
There is still a lot to do, and I think we won't see some important applications in 5 or more years. But if we think that in 1950 graphene was considered a theorical material and not really achievable, waiting just for few years would be nothing.

In the end, about the applications, I'd like to mention Andrej Gejm, who said that the frontier of the future applications is only the human imagination.

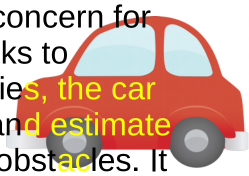
Andrej Gejm answering at the question what graphene is good for: "I don't even know. Is like to present a piece of plastic to one-century-ago-man asking him what is it good for. A bit of everything, I think".



GRAPHENE'S APPLICATIONS

GRAPENE'S APPLICATIONS
Graphene is an innovative technology that could start up a new business and even replace other technologies or materials. The feature of graphene is its property to improve other existing materials and for this reason it will have a positive impact on economic development.

APPLICATIONS IN CARS DRIVING
The first application could concern for example cars driving. Thanks to graphene sensing capabilities, the car will be able to find its way and estimate distance to other cars and obstacles. It could be surely very useful in particular condition such as fog or at night. Besides, the driver can check his vital functions through the steering (graphene is put inside the car's structure), making sure is not falling asleep or suffering from heart problems while driving! Furthermore, graphene is thermally conductive, so it can also reduce temperature build up, indeed, it can heat things when they need and cool them off when they get too hot . In this way during winter the driver wouldn't have to waste time in defrosting his car. Using graphene in tires would make them more resistant: it could be important for example during car races. Researchers are working on it to develop alternative engine technologies as well as electrical cars. In particular graphene can make batteries longer lasting.



COMPOSITES AND COATINGS
Graphene's properties as strength, flexibility, lightweight and conductivity could be used to improve existing products, creating composite materials, also with clothes!
For example, introducing a graphene sensor in swimsuits, we could receive information helping us to train more efficiently. Also swimming teachers could receive signals from swimsuits while monitoring us from the poolside. In fact thanks to its properties, it is able to give signals and it does not break up thanks to its flexibility.
Additionally , the fact that graphene is composed by a single layer of atoms, which can act as a perfect barrier, will give the possibility to open up a large number of new markets and support industrial processes. An idea is to use graphene to protect food and pharmaceutical packaging, because it could stop the transfer of water and oxygen keeping food and perishable goods fresher for a longer time. In fact graphene membranes are able to form a perfect barrier against liquids and gasses (they have even been proved to stop helium, the hardest gas to block).
Another idea to use graphene like a coat is to improve bullet proof vests, adding graphene to carbon nanotubes immersed in a polymer; this mix has shown to be more resistant than Kevlar, the material employed in this kind of protections.

BIOMEDICAL
It is well known that graphene possesses a large amount of unique properties, which have attracted huge attention in optical science, materials science, nanoelectronics and bioscience. With its unique combination of structural and electronic properties, graphene becomes a promising candidate to create sensors that are vital in biological and chemical fields.
Moreover, graphene has superior biocompatibility and extremely high chemical stability, which open up exciting opportunities for social problems including healthcare, security, and life science.

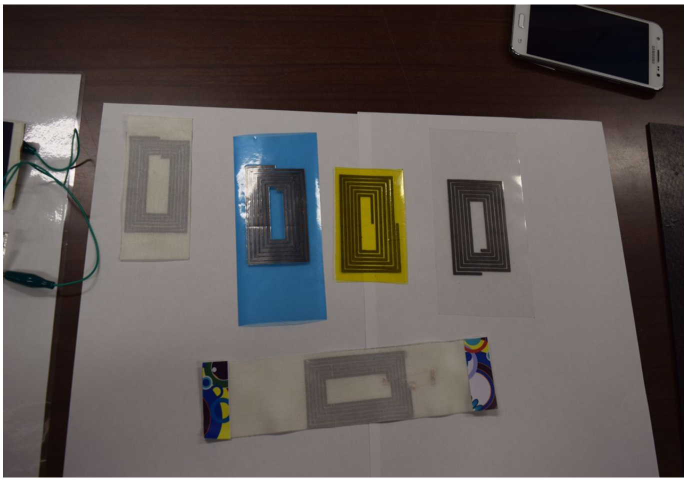
Scientists have recently built a graphene device that could help a blind eyesight go from total black to perceiving shades and shapes. Stimulating the nervous system of the brain, it could record the electrical activity and inject charge into the optical nerve and then produce an image.
Graphene could also help people with parkinson's: in fact, there is a new generation of thin and flexible graphene devices that minimize shaking tremor and other symptoms.
Currently, some other biomedical application are in the process of development, including cancer treatment, tissue engineering and drug delivery; all of this could really make the difference in people's lives.

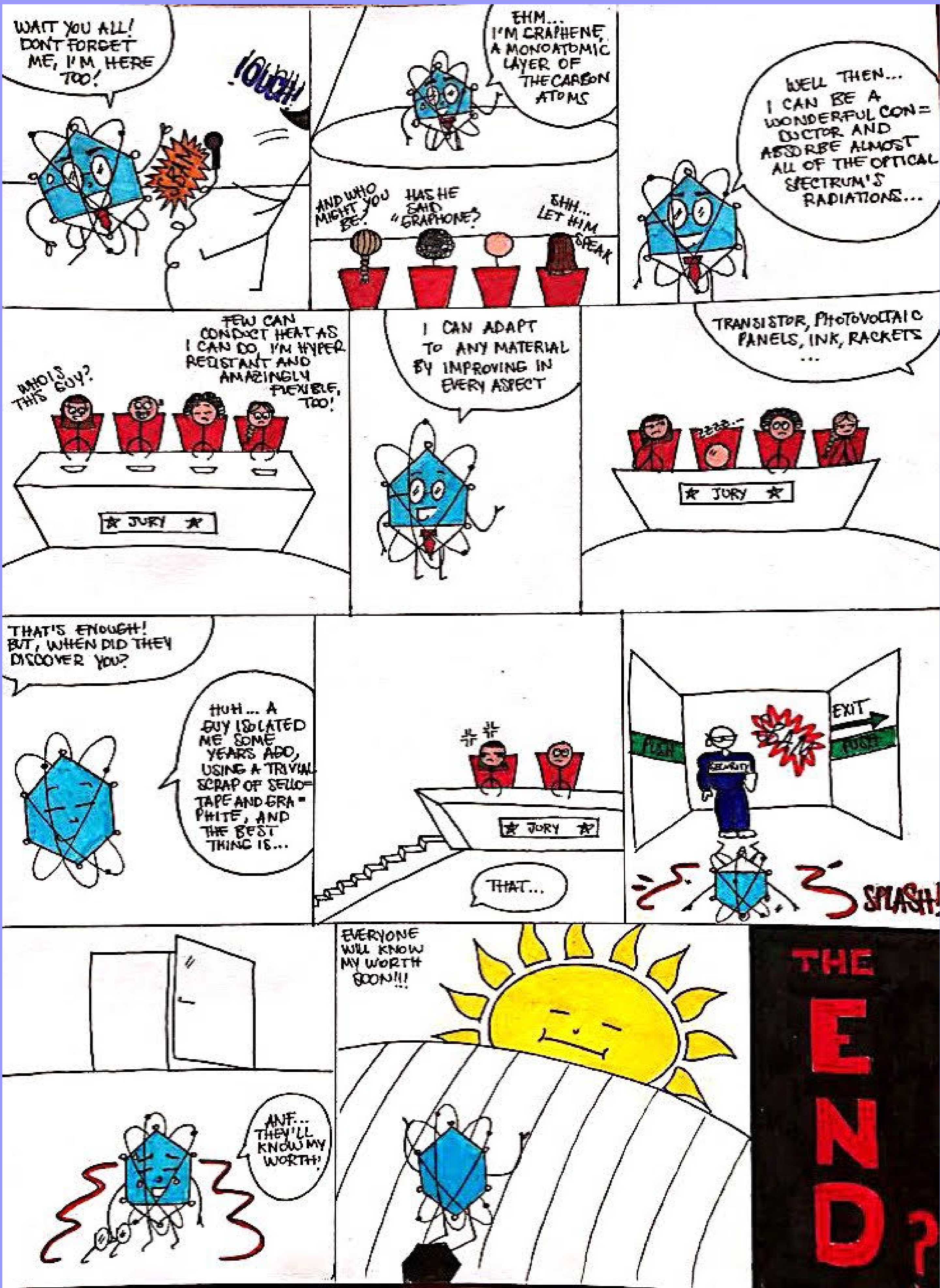
ENERGY
Exceptionally lightweight, resistant and flexible at the same time, even able to effectively
conduct heat and electricity, graphene can give new and better properties at many everyday materials such as mobile batteries or flexible screens.

An electro-material has to conduct electricity, but it should also be light, as energy is stored basically as a function of the volume or the area of the device. Graphene allows batteries to have all the characteristics we need, such as a wide surface or high volume, and more functional batteries, all provided by our light, stable, and conducting material. In fact, a graphene battery can be charged more quickly and can hold more power than a traditional lithium ion battery. This new battery is made up of sheets of aluminum and graphene, and this last material is also able to speed up the recharging.

Thanks to graphene's resistance, we could have flexible power storage, together with blendable batteries and supercapacitors. Graphene supercapacitors could provide massive amounts of power while using much less energy than conventional devices, due to their lightness; they could also reduce cars' or planes' weight.
As far as technology is concerned, graphene would be useful not only as a comfort but also as a necessity: it can substitute some other materials which are essential to create our phones, but are often extracted exploiting people, in particular children. For example, in the Democratic Republic of Congo thousands of children are forced to work in cobalt mines in extremely dangerous conditions to extract this precious mineral, used precisely for the manufacture of mobile phones and smartphones all over the world. Could graphene be a way to put an end to this mistreatment?

As we are relying more and more on renewable energy from the wind, from the tides, from the sun, we also certainly need to store that energy: supercapacitors, with a special attention for those with graphene, could certainly help us and make a huge difference in that field.




WAIT YOU ALL! DON'T FORGET ME, I'M HERE TOO!
OUCH!
SBAM
EHM... I'M GRAPHENE, A MONOATOMIC LAYER OF THE CARBON ATOMS
AND WHO MIGHT YOU BE?
HAS HE SAID "GRAPHONE"?
SHH... LET HIM SPEAK
WELL THEN... I CAN BE A WONDERFUL CON= DUCTOR AND ABSORBE ALMOST ALL OF THE OPTICAL SPECTRUM'S RADIATIONS...
WHO IS THIS GUY?
FEW CAN CONDUCT HEAT AS I CAN DO, I'M HYPER RESISTANT AND AMAZINGLY FLEXIBLE, TOO!
JURY
I CAN ADAPT TO ANY MATERIAL BY IMPROVING IN EVERY ASPECT
TRANSISTOR, PHOTOVOLTAIC PANELS, INK, RACKETS ...
JURY
THAT'S ENOUGH! BUT, WHEN DID THEY DISCOVER YOU?
HUH... A GUY ISOLATED ME SOME YEARS AGO, USING A TRIVIAL SCRAP OF SELLO= TAPE AND GRA= PHITE, AND THE BEST THING IS...
JURY
THAT...
EXIT
PUSH
PUSH
SECURITY
SPLASH!
ANF... THEY'LL KNOW MY WORTH!
EVERYONE WILL KNOW MY WORTH SOON!!!
THE END?

GRAPHENE'S ECONOMY

INTRODUCTION: CURRENT MARKET

Graphene, a material which, as it has been discovered recently, is still under study, has a business that by now is mainly focused on research. In fact, in the last few years this field has been elaborated a great deal.

Particularly, Graphene Flagship has the task to bring graphene, an up-to-date material of multifaceted characteristics, from academic laboratories to the european society in the course of the next ten years with 1million euros price range, in order to create an economic growth. However, its applications would largely overcome mere scientific research.

This is due to the wide range of applications it could be used for: it's much more resistant than steel, super-thin and flexible, and has an high electrical conductivity. The several areas in which it could be used, as we have shown in previous articles, are the following: biomedical, clothing, sport devices, energetic and mechanic/industrial field, technological and electronic.

Indeed, graphene would substitute many limited available materials such as ITO, about which we'll deepen then, together with Carbon, for fishing poles, bicycles and helmets, and Kevlar for bulletproof vests…

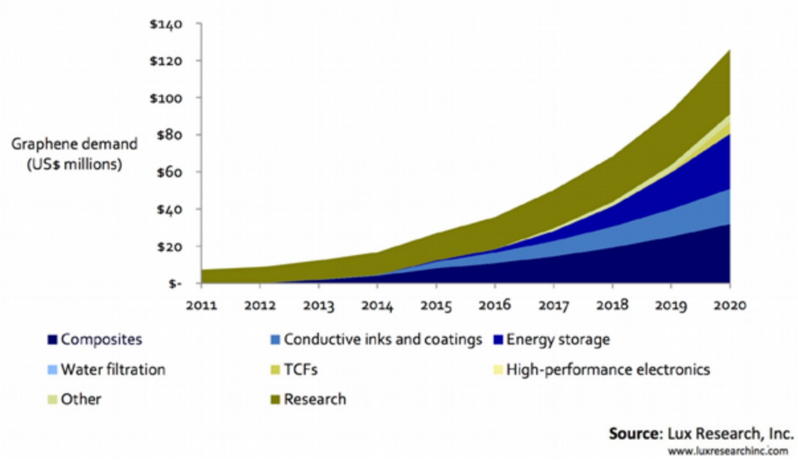
-I.T.O.

ITO is a material which is fundamental to many of the electronics (liquid cristal displays, flat, plasma and touch screens, organic light-emitting diodes, photovoltaic cells, anti-static coatings and anti-electromagnetic interference shields).

Nevertheless, this material has an highly restricted availability, which involves itself instability in price and provision; moreover, ITO is produced almost exclusively in economically or politically vulnerable non-european countries.

It means a proper economic dependence on those countries, as well as a fluctuating price, which is continuously falling; assuming it as scarcely available but still fundamental in our economy.

The only stumbling block to overcome is to find a cheap method to produce graphene industrially from carbon, being this last easily accessible and low-priced. We shouldn't consider it an unreachable achievement since graphene was discovered only in 2004, and in the last few years we have made important steps forward. Indeed, forecasts for its future economic implications are really positive. As it's shown in the chart, within a few years the supply should be 100% higher than nowadays.



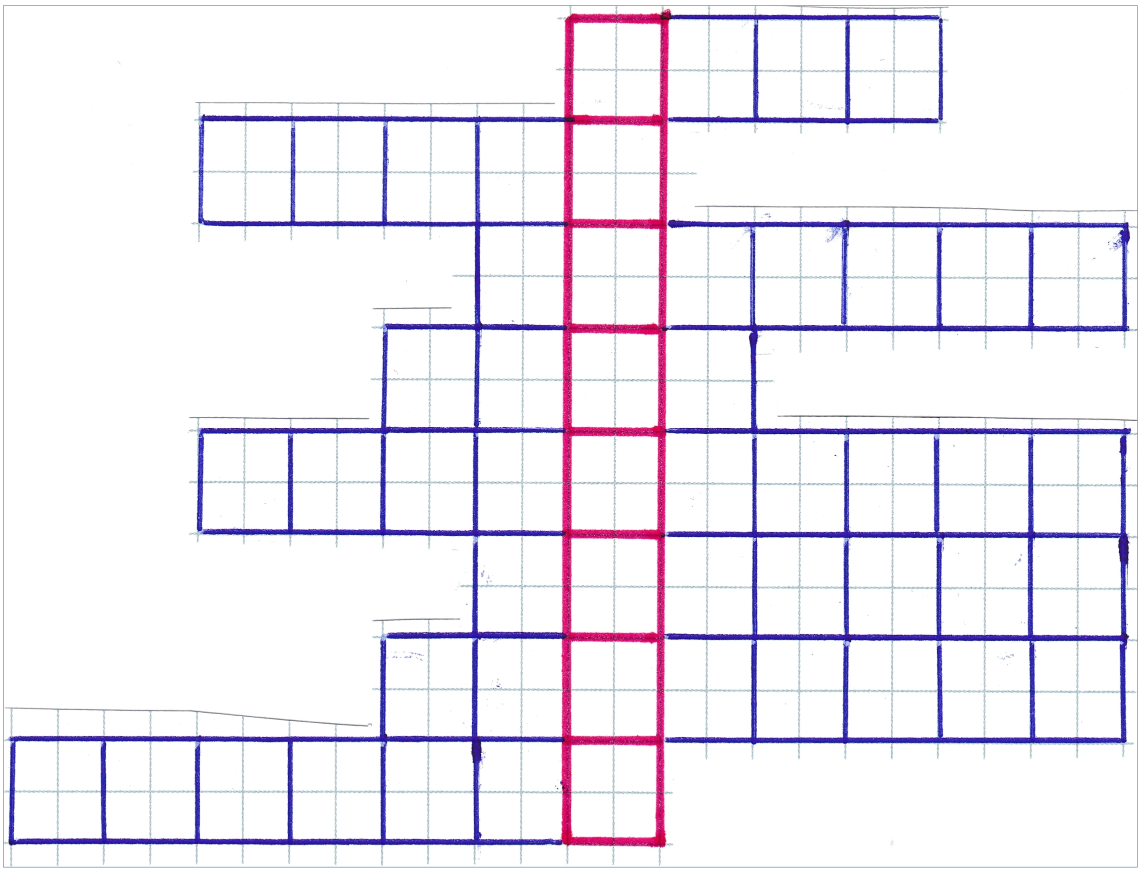
Even if graphene is still in the research phase, it's already on the market.

Unfortunately quality isn't always certifiable: in fact graphene forms of different qualities have already been introduced on the market and some of them are cheap materials. Furthermore a little difference of quality is synonymous with a huge difference in applications field.

For this reason more in-depth studies are necessary, in order to develop an industrial production of high-quality graphene. In fact all world powers have started a business in this area.

For all these reasons graphene is a great solution.

1. One of the scientists that won the Nobel prize in physics thanks to his work on graphene.
2. Graphene can be used to purify the ...
3. What will the graphene improve in the tennis equipment?
4. Which was the first way that scientists used to obtain graphene?
5. In which university was graphene discovered?
6. Which is the shape of a graphene's molecula?
7. Which material will the graphene substitute in a lightbulbs?
8. From which material graphene come from?



1 Gejm - 2 Water- 3 Racquet- 4 Tape- 5 Manchester -6 Hexagon
-7 Tungsten – 8 Graphite

THANKS FOR READING!

CLASS 3A, LICEO N. COPERNICO, BOLOGNA, ITALY

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